

## EMB190 Alerting Issues – Single engine failure/fire

### 1. Initiating Condition: Engine failure after V1 and prior to V2

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
<b>Visual Alerts</b>	Amber boxed FAIL text on the EICAS panel N1 indicator of the failed engine	FADEC detects engine flamed out or shut down without pilot action				Alert is removed when the failed engine's master has been turned off as part of the engine failure procedure
	Red boxed value on the EICAS panel oil pressure indicator of the failed engine	Oil pressure below operating limit (< 24 psi)		Low oil pressure alert may precede the engine FAIL alert, be simultaneous with it, or be seconds after it depending on cause of engine failure		
	EICAS caution ENG 1 or 2 FAIL (Amber, flashing, reverse video)	FADEC detects engine flamed out or shut down without pilot action		This alert is inhibited during takeoff roll, so in this condition it is first presented during climb.	Inhibited during takeoff from 80 knots through 400 feet	Flashing/reverse video of the text ceases when the master caution light/pushbutton is pressed; Alert is removed when the failed engine's master has been turned off as part of the engine failure procedure
	Master caution blinking amber lights on L&R glareshield	Triggered by EICAS Caution Message ENG 1 or 2 FAIL		This alert is inhibited during takeoff roll, so in this condition it is first presented during climb.	Inhibited during takeoff from 80 knots through 400 feet	Blinking terminates when the Master Caution light/pushbutton is pressed
<b>Aural Alerts</b>	Repetitive chime	Triggered by EICAS Caution Message ENG 1 or 2 FAIL		This alert is inhibited during takeoff roll, so in this condition it is first presented during climb.	Inhibited during takeoff from 80 knots through 400 feet	Chime terminates when the Master Caution light/pushbutton is pressed
<b>Tactile Alerts</b>	None					

## EMB190 Alerting Issues – Single engine failure/fire

### 1. Initiating Condition: Engine failure after V1 and prior to V2 – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Visual Cues	Abnormal ITT, N1, N2, oil temperature, and/or oil pressure gauge indications					
	Nose yawing off runway centerline					
Aural Cues	Sounds of engine malfunction may occur		These sounds may be similar to those from engine surge and tire failure			
Tactile/ Somatic Cues	Lateral g					
	Rudder pressure required to stay on runway					
	Reduced longitudinal acceleration					

#### Expected Pilot Response(s)

- Control the aircraft
- Execute single engine takeoff/climb profile
- Identify and execute appropriate non-normal checklist (above 400 feet agl)
- Perform single engine approach and landing

#### Possible sources of confusion with regard to pilot response(s)

- Stress, time pressure, startle.
- Confusion among engine surge, engine failure, tire blowout.
- Partial engine failure may present difficult diagnosis and decision as to whether to shut down.

#### Issues with regard to multiple concurrent non-normal conditions

- Engine failure presents concurrent electrical, hydraulic, and/or fuel system failures or issues that may require additional action.
- Uncontained engine failure may present additional multiple alerts and failures.

## EMB190 Alerting Issues – Single engine failure/fire

### 2. Initiating Condition: Engine failure in cruise flight with autopilot engaged

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
<b>Visual Alerts</b>	Amber boxed FAIL text on the EICAS panel N1 indicator of the failed engine	FADEC detects engine flamed out or shut down without pilot action				Alert is removed when the failed engine's master has been turned off as part of the engine failure procedure
	Red boxed value on the EICAS panel oil pressure indicator of the failed engine	Oil pressure below operating limit (< 24 psi)		Low oil pressure alert may precede the engine FAIL alert, be simultaneous with it, or be seconds after it depending on cause of engine failure		
	EICAS caution ENG (1 or 2) FAIL (Amber, flashing, reverse video)	FADEC detects engine flamed out or shut down without pilot action			Inhibited during takeoff from 80 knots through 400 feet	Flashing/reverse video of the text ceases when the master caution light/pushbutton is pressed; Alert is removed when the failed engine's master has been turned off as part of the engine failure procedure
	Master caution blinking amber lights on L&R glareshield	Triggered by EICAS Caution Message ENG (1 or 2) FAIL			Inhibited during takeoff from 80 knots through 400 feet	Blinking terminates when the Master Caution light/pushbutton is pressed
<b>Aural Alerts</b>	Repetitive chime	Triggered by EICAS Caution Message ENG (1 or 2) FAIL			Inhibited during takeoff from 80 knots through 400 feet	Chime terminates when the Master Caution light/pushbutton is pressed
<b>Tactile Alerts</b>	None					

## EMB190 Alerting Issues – Single engine failure/fire

### 2. Initiating Condition: Engine failure in cruise flight with autopilot engaged – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
Visual Cues	Abnormal ITT, N1, N2, oil temperature, and/or oil pressure gauge indications					
Aural Cues	Sounds of engine malfunction may occur		These sounds may be similar to those from engine surge and tire failure			
Tactile/ Somatic Cues	Wheel may move opposite the roll if autopilot is engaged.					Control wheel displacement cues are reduced/eliminated after trimming the rudder

#### Expected Pilot Response(s)

- Control the aircraft
- Identify and execute appropriate non-normal checklist
- Perform single engine approach and landing

#### Possible sources of confusion with regard to pilot response(s)

- Stress, time pressure, startle.
- Partial engine failure may present difficult diagnosis and decision as to whether to shut down.
- Confusion among engine surge, engine failure.
- Secondary failures (hydraulic, electrical) may distract from diagnosis and hamper reaction to engine failure

#### Issues with regard to multiple concurrent non-normal conditions

- Engine failure presents concurrent electrical, hydraulic, and/or fuel system alerts, cues that may require additional action.
- Uncontained engine failure may present additional multiple alerts and failures.

## EMB190 Alerting Issues – Single engine failure/fire

### 3. Initiating Condition: Engine fire after V1 and prior to V2

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
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Visual Alerts	Fire extinguisher handle illuminates in red on overhead panel	Temperature sensed by one or more engine fire loops				Alert terminates if the fire detection system senses that the fire has been extinguished, or the fire detection system has failed (burnthrough)
	Master Warning blinking red lights on L&R glareshield	Temperature sensed by one or more engine fire loops				Blinking terminates when the Master Warning light/pushbutton is pressed
	Red boxed FIRE text on the EICAS panel ITT indicator of the affected engine	Temperature sensed by one or more engine fire loops				Alert terminates if the fire detection system senses that the fire has been extinguished, or the fire detection system has failed (burnthrough)
	EICAS warning ENG (1 or 2) FIRE (Red, flashing, reverse video)	Temperature sensed by one or more engine fire loops				Flashing/reverse video of the text ceases when the Master Warning light/pushbutton is pressed; Alert terminates if the fire detection system senses that the fire has been extinguished, or the fire detection system has failed (burnthrough)

## EMB190 Alerting Issues – Single engine failure/fire

### 3. Initiating Condition: Engine fire after V1 and prior to V2 – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
<b>Visual Alerts</b>	EICAS caution ENG (1 or 2) FIRE DET FAIL	Fire detection built-in test determines that the fire detection system has been compromised (e.g., due to fire damage/burnthrough)	Pilots must retrieve and apply the systems knowledge that a fire warning that then ceases, accompanied by this FIRE DET FAIL indication, together suggests that the fire has not been extinguished -- further, the failure of the detection system suggests that the fire may have worsened; if not, they may mistakenly conclude that the fire has been extinguished.		Inhibited during takeoff from 80 knots through 400 feet and during landing from 200 feet through 30 seconds after touchdown	
	Master caution blinking amber lights on L&R glareshield	Triggered by EICAS Caution Message ENG (1 or 2) FIRE DET FAIL			Inhibited during takeoff from 80 knots through 400 feet and during landing from 200 feet through 30 seconds after touchdown	Blinking terminates when the Master Caution light/pushbutton is pressed
<b>Aural Alerts</b>	Continuous fire bell with repetitive triple chime	Temperature sensed by one or more engine fire loops				Bell and triple chime terminates when the Master Warning light/pushbutton is pressed; Alert terminates if the fire detection system senses that the fire has been extinguished, or the fire detection system has failed (burnthrough)

## EMB190 Alerting Issues – Single engine failure/fire

### 3. Initiating Condition: Engine fire after V1 and prior to V2 – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
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<b>Aural Alerts</b>	Repetitive chime	Triggered by EICAS Caution Message ENG (1 or 2) FIRE DET FAIL			Inhibited during takeoff from 80 knots through 400 feet and during landing from 200 feet through 30 seconds after touchdown	Chime terminates when the Master Caution light/pushbutton is pressed
<b>Tactile Alerts</b>	None unless engine also fails					
<b>Visual Cues</b>	None unless engine also fails					
<b>Aural Cues</b>	None					
<b>Tactile/Somatic Cues</b>	None unless engine also fails					

#### Expected Pilot Response(s)

- Control the aircraft
- Execute V1 engine failure/fire flight profile
- Execute engine fire procedure (begin procedure above 400 feet AFE)
- Perform single engine approach/landing procedures

#### Possible sources of confusion with regard to pilot response(s)

- False fire warning cannot readily be distinguished from valid fire warning (see condition 4 below).
- False indication of fire extinguishment is possible if fire is severe enough to fail both fire loops

#### How does pilot know condition is resolved/recovered?

- Fire warning indication that fire is extinguished

## **EMB190 Alerting Issues – Single engine failure/fire**

3. Initiating Condition: Engine fire after V1 and prior to V2 – Cont.

### **Issues with regard to multiple concurrent non-normal conditions**

- Engine fire will devolve to an engine failure, either as a direct result of and simultaneous with the fire onset or as part of the engine fire procedure.
- Engine fire presents concurrent electrical, hydraulic, and/or fuel system issues that may require additional action.
- Engine fire may present cascading emergency (e.g., hydraulic failures, smoke in cabin, etc.)
- Uncontrollable fire may present additional, cascading conditions (e.g., structural failure, fuel loss, need to expedite landing or even land off-airport).



## EMB190 Alerting Issues – Single engine failure/fire

### 4. Initiating Condition: False fire warning from engine bleed leak, during takeoff after V1 and before V2

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
<b>Visual Alerts</b>	Fire extinguisher handle illuminates in red on overhead panel	Temperature sensed by one or more engine fire loops	Warning is false, there is no fire. There are no salient cues to the fact that there is no fire; absence of engine failure is not, in itself, diagnostic of a false fire warning.	False fire warning can lead to unneeded RTO, engine shutdown, etc.		Alert terminates if the fire detection system senses that the fire has been extinguished
	Master Warning blinking red lights on L&R glareshield	Temperature sensed by one or more engine fire loops	Warning is false, there is no fire. There are no salient cues to the fact that there is no fire; absence of engine failure is not, in itself, diagnostic of a false fire warning.	False fire warning can lead to unneeded RTO, engine shutdown, etc.		Blinking terminates when the Master Warning light/pushbutton is pressed
	Red boxed FIRE text on the EICAS panel ITT indicator of the affected engine	Temperature sensed by one or more engine fire loops	Warning is false, there is no fire. There are no salient cues to the fact that there is no fire; absence of engine failure is not, in itself, diagnostic of a false fire warning.	False fire warning can lead to unneeded RTO, engine shutdown, etc.		Alert terminates if the fire detection system senses that the fire has been extinguished
	EICAS warning ENG (1 or 2) FIRE (Red, flashing, reverse video)	Temperature sensed by one or more engine fire loops	Warning is false, there is no fire. There are no salient cues to the fact that there is no fire; absence of engine failure is not, in itself, diagnostic of a false fire warning.	False fire warning can lead to unneeded RTO, engine shutdown, etc.		Flashing/reverse video of the text ceases when the Master Warning light/pushbutton is pressed; Alert terminates if the fire detection system senses that the fire has been extinguished

## EMB190 Alerting Issues – Single engine failure/fire

4. Initiating Condition: False fire warning from engine bleed leak, during takeoff after V1 and before V2 – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
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<b>Aural Alerts</b>	Continuous fire bell with repetitive triple chime	Temperature sensed by one or more engine fire loops	Warning is false, there is no fire. There are no salient cues to the fact that there is no fire; absence of engine failure is not, in itself, diagnostic of a false fire warning.	False fire warning can lead to unneeded RTO, engine shutdown, etc.		Bell and triple chime terminates when the Master Warning light/pushbutton is pressed; Alert terminates if the fire detection system senses that the fire has been extinguished
<b>Tactile Alerts</b>	None					
<b>Visual Cues</b>	None					
<b>Aural Cues</b>	None					
<b>Tactile/Somatic Cues</b>	None					

### Expected Pilot Response(s)

- Control the aircraft
- Execute V1 engine failure/fire flight profile
- Execute engine fire procedure (begin procedure above 400 feet)
- Perform single engine approach/landing procedures

### Possible sources of confusion with regard to pilot response(s)

- False fire warning cannot readily be distinguished from valid fire warning (see condition3 above).

## **EMB190 Alerting Issues – Single engine failure/fire**

4. Initiating Condition: False fire warning from engine bleed leak, during takeoff after V1 and before V2 – Cont.

### **Issues with regard to multiple concurrent non-normal conditions**

- False indication of engine fire will likely devolve to an engine failure as part of the engine fire procedure.
- If false indication of fire continues after engine fire NNPs are performed, pilot concerns about inextinguishable fire may prompt risky alternative actions (e.g., rushing, off-airport landing, etc)